TESTING AND ANALYSIS OF DOD ADA LANGUAGE PRODUCTS FOR NASA

RTOP 506-58 AND 482-58

AN ACTIVITY IS DESCRIBED WHICH IS KEYED TO JSC'S ROLE AS AN ADA/APSE TEST SITE UNDER THE AUSPICES OF THE OAST AGREEMENT WITH DOD ESTABLISHING NASA/DOD COOPERATION IN THE STARS PROGRAM. I PROVIDED ELABORATION ON A CONTRACT WITH UH/CLC WHICH MINIMIZES USE OF LOCAL CONTRACTOR IR&D EFFORTS TO TEST AN EVALUATE ADA AND APSE FOR NASA. SPECIFIC OBJECTIVES AND CONCERNS RELATIVE TO POTENTIAL UTILIZATION OF ADA FOR SPACE STATION ARE DISCUSSED. FINALLY, DETAILED DISCUSSION IS PROVIDED IN REFERENCE TO STUDY TASKS SOON TO BE CONTRACTED OUT FOR DETAILED INVESTIGATION AND PROJECT RISK ASSESSMENT.

TESTING AND ANALYSIS OF DOD ADA LANGUAGE PRODUCTS FOR NASA

RTOP #506-58

JOHNSON SPACE CENTER
AVIONICS SYSTEMS DIVISION
APRIL 1985

WHY IS NASA INVESTIGATING ADA

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- SIZE AND COST OF SOFTWARE INCREASING SIGNIFICANTLY IN NASA SPACE FLIGHT SYSTEMS

- NASA MUST REDUCE SOFTWARE DEVELOPMENT AND ESPECIALLY MAINTENANCE COSTS OF SOFTWARE OVER LONG LIFE-CYCLE PROJECTS

- ADA IS STATE-OF-ART AND STANDARD DOD LANGUAGE DESIGNED FOR EMBEDDED COMPUTERS. (EMBEDDED COMPUTERS USED IN NASA SPACE FLIGHT SYSTEMS)

- ADA WAS DESIGNED TO "REDUCE COSTS" IN DEVELOPMENT AND MAINTENANCE OF SOFTWARE FOR EMBEDDED COMPUTER APPLICATIONS :
  - MANDATORY VALIDATION OF ADA COMPILERS PROVIDES :
    - REUSABLE SOFTWARE MODULES FROM ONE PROJECT TO ANOTHER EVEN IF DIFFERENT TARGET COMPUTERS ARE USED
    - PORTABLE SOFTWARE DEVELOPMENT/MAINTENANCE TOOLS (WRITTEN IN ADA)
  - LANGUAGE FEATURES THAT REDUCE ERRORS :
    - HIGHLY STRUCTURED (MAKES BRANCHING HIGHLY VISIBLE AND MORE CONTROLLED)
    - READABLE (MORE DESCRIPTIVE KEY WORDS, STANDARD LANGUAGE, ETC.)
    - WELL-DOCUMENTED PROGRAMS (USER-DEFINED DATA TYPES, ALL DATA EXPLICITLY DEFINED, ETC.)
    - MORE ERROR CHECKING BY COMPILER BECAUSE PROGRAMMER MUST PROVIDE MORE EXPLICIT INFORMATION
  - BUILT-IN AND AUTOMATED SOFTWARE CONFIGURATION CONTROL VIA HIGHLY INTEGRATED COMPILER, DATA BASE AND CONFIGURATION CONTROL TOOLS.

- COSTS OF LANGUAGE DEVELOPMENT AND MAINTENANCE WILL BE SHARED BY DOD

PROJECT BACKGROUND

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- JSC RTOP APPROVED BY OAST IN JUNE 1983.

- MEMO OF AGREEMENT SIGNED IN JUNE 1983 BETWEEN DOD AND OAST ESTABLISHING NASA/DOD COOPERATION IN DOD'S SOFTWARE TECHNOLOGY FOR ADAPTABLE, RELIABLE SYSTEMS (STARS) PROGRAM. JOINT JSC/UH-CL ADA/APSE TEST SITE AND EVALUATION PROJECT RECOGNIZED IN MEMO.

- CONTRACT ESTABLISHED SEPTEMBER 1983 BETWEEN JSC AND UH-CL HIGH TECHNOLOGIES LAB TO :

  - PROVIDE GENERAL CONTRACTUAL BASIS FOR FUTURE SPECIFIC TASK AGREEMENTS WITH JSC IN SUPPORT OF RTOP.
  - PROVIDES SOURCE FOR ADA/APSE EXPERTISE AND CONSULTATION
  - ENABLES LOCAL-AREA CONTRACTORS TO COORDINATE THEIR IR&D EFFORTS THRU UH-CL IN SUPPORT OF JSC ADA PROJECT.

- RESULT IS A JOINT JSC/FA&EA, UH-CL, AND LOCAL-AREA CONTRACTOR PROJECT TO TEST AND EVALUATE ADA AND APSE FOR NASA.

- TEST AND EVALUATE ADA LANGUAGE AND TOOLS FOR THEIR APPLICABILITY FOR USE IN FUTURE NASA FLIGHT SYSTEMS.
  - -- TECHNOLOGY FOCUSED ON SPACE STATION
- DEVELOP NASA STANDARDS AND POLICIES ON USE OF ADA.
- DEVELOP PLANS AND GUIDELINES FOR TRANSITIONING FROM HAL/S TO ADA ON FUTURE NASA FLIGHT SYSTEMS.

MAJOR PROJECT TASKS	AVIONICS SYSTEMS DIVISION	
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1. INSTALLATION AND MAINTENANCE OF APSE'S
   - ESTABLISH JSC/DOD COORDINATION
   - INSTALL APSE'S ON APPROPRIATE JSC AND UH-CL COMPUTER SYSTEMS
   - GENERATE AND ESTABLISH APSE CONFIGURATION CONTROLS
2. ADA/APSE TESTING AND EVALUATION
   - PERFORM MATRIX ANALYSIS OF REQUIREMENTS VERSUS IMPLEMENTATION
   - INVESTIGATE APSE AND ADA TRANSPORTABILITY
   - EVALUATE PERFORMANCE AND CAPABILITIES OF ADA AND APSE BY BENCHMARK COMPARISONS WITH HAL/S AND ITS ENVIRONMENT.
3. DEVELOP PROTOTYPE SOFTWARE APPLICABLE TO NASA FLIGHT SYSTEMS
   - PROVIDE ADA TOOLS FOR USE BY LOCAL-AREA COMPANIES IN THEIR IR&D ADA PROJECTS RELATED TO JSC RTOP.
   - USE ADA AND APSE TO DEVELOP PROTOTYPE SOFTWARE FOR A DISTRIBUTED COMPUTER NETWORK IN THE SPACE STATION DATA MANAGEMENT SYSTEM TESTBED.
4. DEVELOP RECOMMENDATION REPORT ON SELECTION OF ADA FOR SPACE STATION FLIGHT SYSTEMS
   - IDENTIFY KEY PROBLEMS VIA MAJOR TASKS 2 AND 3.
   - PERFORM FOCUSED TECHNICAL STUDIES AND DEVELOP SOFTWARE PROTOTYPES FOR KEY PROBLEM AREAS
   - ASSESS RISK OF PROBLEM AREAS TO SPACE STATION PROJECT
   - DEVELOP ADA DECISION MATRIX
5. NASA STANDARDS AND TRANSITION
   - DEVELOP A NOMINAL SET OF STANDARDS AND POLICIES FOR USE OF ADA ON NASA PROJECTS
   - DEVELOP A PLAN FOR TRANSITIONING FROM THE HAL/S STANDARD TO ADA FOR AGENCY FLIGHT SOFTWARE PROJECTS

- PROJECT MANAGER - JACK GARMAN (FD)
- ASSISTANT PROJECT MANAGER - ED CHEVERS (EH)
- PROJECT TECHNICAL MANAGERS - TERRY HUMPHREY (EH4)
  STEVE GORMAN (FD)
- ADA/APSE CONSULTANT AND COORDINATOR OF PARTICIPATING LOCAL-AREA COMPANIES - DR. CHARLES MCKAY (UH-CL)
- 22 LOCAL-AREA COMPANIES DONATING IR&D RESOURCES: (ABOUT 70 HALF-TIME PERSONNEL)

BARRIOS TECHNOLOGY	LOCKHEED (LEMSCO)
BOEING AEROSPACE	MARTIN MARIETTA
CHARLES STARK DRAPER LABS	MCDONNELL DOUGLAS (MDTSCO)
COMPUTER SCIENCES CORP.	MITRE CORP.
DATA GENERAL	
FORD AEROSPACE	ROCKWELL INT'L
GRUMMAN DATA SYSTEMS	SINGER (LINK)
HARRIS CORP.	
HICKOK ELECTRICAL INSTRUMENTS	SOFTECH
IBM (FSD)	SPERRY UNIVAC
INTERMETRICS	TIMOTHY ALBERT AND ASSOC.
LITTON-MELLONICS	TRW

CONTINUING PROJECT ACTIVITIES	AVIONICS SYSTEMS DIVISION	
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- MONTHLY JSC/UH-CL ADA STEERING GROUP MEETINGS WITH 22 PARTICIPATING COMPANIES.
  - STEER AND REVIEW STATUS OF PROJECT
  - REVIEW ADA TECHNOLOGY OBJECTIVES AND PLANS (ATOPs) WHICH DEFINE SUBTASKS TO BE PERFORMED BY PROJECT PARTICIPANTS.
- WEEKLY ADA/APSE TECHNICAL EXCHANGE MEETINGS BETWEEN UH-CL, JSC AND THE LOCAL PARTICIPATING COMPANIES.
- 64 ATOPs CURRENTLY DEFINED AND IN WORK BY 21 PARTICIPATING COMPANIES USING JSC AND UH-CL ADA SUPPORT TOOLS AND COMPUTERS.
- ADA/APSE TRAINING THRU UH-CL.

C-3

COMPLETED MILESTONES

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DOD/NASA MEMO OF AGREEMENT ON STARS PROGRAM	JUNE 1983
JSC/UH-CL CONTRACT ESTABLISHED	SEPT 1983
JOINT JSC/UH-CL/LOCAL-AREA COMPANIES ADA STEERING GROUP ESTABLISHED	OCT 1983
COMMERCIAL NON-VALIDATED ADA SYSTEMS INSTALLED (TELESOFT, NYU-ADA/ED, INTEL 432)	JAN 1984
AIR FORCE/INTERMETRICS BOOTSTRAPPED ADA SYSTEM INSTALLED (NON-VALIDATED COMPILER)	FEB 1984
23 ATOPs SUBMITTED AND APPROVED	JUN 1984
ROLM / DATA GENERAL VALIDATED-ADA WORKSTATIONS LOANED TO JSC AND UH-CL	OCT 1984
ADA EVALUATION WHITE PAPERS COLLECTED FROM PROJECT PARTICIPANTS	NOV 1984
WHITE PAPERS CONSOLIDATED INTO LIST OF CURRENT PROBLEMS AND CONCERNS ABOUT ADA FOR SPACE STATION	DEC 1984
ARMY/SOFTECH VALIDATED-ADA SYSTEM (ALS) INSTALLED AT UH-CL, JSC, KSC, GSFC AND JPL	JAN/FEB 1985
64 ATOPs DEFINED AND IN-WORK BY 21 COMPANIES	FEB 1985
ATOP MINI-SYMPOSIUM AT JSC	FEB 1985
IDENTIFY KEY PROBLEMS WITH ADA/APSE FOR SPACE STATION PROJECT (INTERMETRICS AND JPL STUDIES)	FEB & APR 1985
COMPLETED BETA TESTING OF VAX ADA	MAR 1985

PROJECTED MILESTONES	AVIONICS SYSTEMS DIVISION	
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CONTRACTS AND ATOPS TO INVESTIGATE KEY ADA/APSE PROBLEMS AND ASSESS RISKS TO SPACE STATION PROJECT	APR 1985
DATA GENERAL/ROLM MV8000 ADE AND DEC VAX ADA PURCHASED AND INSTALLED AT JSC	JULY 1985
AIR FORCE/INTERMETRICS VALIDATED AIE INSTALLATION AT JSC AND UH-CL	SEPT 1985

NOTE! THE FOLLOWING MILESTONES ARE KEYED TO SPACE STATION PHASE B MILESTONES :

PROJECT REPORT AND RECOMMENDATION ON SELECTION OF ADA AS SPACE STATION LANGUAGE (PRIOR TO SSE RFP)	JAN 1986
SPACE STATION SOFTWARE SUPPORT ENVIRONMENT (SSE) REQUEST FOR PROPOSALS (RFP)	APR 1986
NASA ADA/APSE STANDARDS DEFINED (PRIOR TO SSE PDR)	NOV 1986
HAL/S TO ADA TRANSITION PLAN FOR SPACE STATION (PRIOR TO SSE PDR)	DEC 1986
SPACE STATION SDE PRELIMINARY DESIGN REVIEW (PDR)	JAN 1987

A RECOMMENDATION REPORT ON
SELECTION OF ADA FOR SPACE STATIN

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PROBLEMS/CONCERNS SUBMITTED THRU WHITE PAPERS PROVIDED BY PARTICIPATING CONTRACTORS (Nov. 1985)

CONSOLIDATED LIST GENERATED FROM WHITE PAPERS (Dec. 1985)

STUDY CONTRACTS BY INTERMETRICS AND JPL TO INDEPENDENTLY IDENTIFY KEY PROBLEMS FOR INVESTIGATION IN ORDER TO EVALUATE ADA FOR SPACE STATION (Feb. & Apr. 1985)

KEY PROBLEMS/CONCERNS IDENTIFIED AND TASKS SELECTED FROM CONSOLIDATED WHITE PAPER LIST AND INTERMETRICS/JPL STUDY REPORTS. FIVE STUDY CONTRACTS DEFINED TO INVESTIGATE THESE PROBLEMS AND TO ASSESS SEVERITY AND RISK TO SPACE STATION PROJECT IF ADA SELECTED.
(STUDY DURATION : May - Oct. 1985)

RECOMMENDATION REPORT ON SELECTION OF ADA FOR SPACE STATION TO BE GENERATED AND SUBMITTED (Jan. 1986)

ADA FOR SPACE STATION PROBLEMS AND CONCERNS

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(CONSOLIDATED LIST FROM WHITE PAPERS)

I. ADA LANGUAGE FEATURES AND CAPABILITIES (SUITABLE FOR IMPLEMENTING SPACE STATION REQUIREMENTS)

1 - FOR IMPLEMENTING REAL-TIME SOFTWARE FOR FAULT-TOLERANT,
1 DISTRIBUTED PROCESSING, AND HIGHLY RELIABLE SYSTEMS:
1 - COMPUTER AND NETWORK OPERATING SYSTEMS
1 (INTERRUPT HANDLING VIA ADA TASKING, ETC.)
1 - FAULT TOLERANT RECOVERY/RESTART SOFTWARE FOR MAN-RATED SYSTEMS
1 (EXCEPTION HANDLERS AND RECOVERY BLOCKS, ETC.)
1 - FLIGHT CONTROL SOFTWARE
1 (PRECISE CYCLIC PROCESSING SUPPORT, TASK ACTIVATION, SYNCHRONOUS
1 AND ASYNCHRONOUS TASK SCHEDULING, ETC.)
1 - COMMUNICATIONS AMONG ADA TASKS IN A DISTRIBUTED COMPUTER
1 (RENDEZVOUS CAPABILITIES AND EFFICIENCIES, ETC.)
2 - INTERFACING ADA WITH HAL/S AND OTHER LANGUAGES
3 - ADA LANGUAGE FEATURES WHICH HINDER TESTABILITY AND VERIFICATION OF
3 SOFTWARE FOR MAN-RATED SYSTEMS
3 (DYNAMIC MEMORY ALLOCATION, ETC.)

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II. ADA LANGUAGE STANDARDS
- DIFFERENCES IN OPERATION OF PROGRAMS GENERATED FROM THE SAME ADA SOURCE CODE BUT USING DIFFERENT VALIDATED ADA COMPILERS (DUE TO LACK OF COVERAGE IN ADA VALIDATION TEST SUITE AND LACK OF COVERAGE IN ADA LANGUAGE SPECIFICATION)
- IMPLEMENTED "OPTIONAL ADA FEATURES" NOT TESTED IN ADA VALIDATION TEST SUITE
- PERFORMANCE OF ADA TOOLS AND TARGET CODE NOT MEASURED BY ADA VALIDATION TEST SUITE

III. AVAILABILITY OF SUITABLE ADA TOOLS (TO SUPPORT TRAINING, PROOF-OF-DESIGN PROTOTYPING, AND DESIGN AND DEVELOPMENT SCHEDULES FOR SPACE STATION)

4 - TBD MINIMUM SET OF ADA TOOLS (MAPSE+) :
4 - VALIDATED COMPILER PLUS TBD OPTIONAL LANGUAGE FEATURES
4 - TOOLS FOR SPACE STATION TBD HOST COMPUTER/OPERATING SYSTEMS
4 - TOOLS/ENVIRONMENT COMPATIBLE WITH SPF HAL/S TOOLS/ENVIRONMENT
4 - MAPSE+ TOOLS SUPPORTING DISTRIBUTED HOST COMPUTER SYSTEMS
4 - TOOLS FOR SPACE STATION TBD TARGET COMPUTER/OPERATING SYSTEMS
4 - STATIC AND DYNAMIC ANALYSIS TOOLS FOR CONCURRENT TASKING AND EXCEPTION HANDLING, ETC.
4 - SOURCE-LEVEL DEBUGGER FOR USER-INTERACTIVE DEBUGGING OF CODE ON TARGET COMPUTER SYSTEMS.
4 - MAPSE+ TOOLS SUPPORTING DISTRIBUTED TARGET COMPUTER SYSTEMS TESTING.

ADA FOR SPACE STATION
PROBLEMS AND CONCERNS - CONT.

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IV. LACK OF STONEMAN, CAIS, AND NASA STANDARDS TO SUPPORT :
- REUSABILITY/RETARGETABILITY OF ADA SOFTWARE FOR DIFFERENT TYPE TARGET COMPUTERS AND OPERATING SYSTEMS
  - NEED NASA PROGRAMMING STANDARDS FOR ADA
  - NEED INTERFACE STANDARDS BETWEEN TARGET CODE AND TARGET RUN-TIME SUPPORT SOFTWARE
- TRANSPORTABILITY AND INTEROPERABILITY OF MAPSES, APSES, OR PARTS THEREOF AMONG DIFFERENT TYPE HOST COMPUTERS AND OPERATING SYSTEMS.
- PORTABILITY OF PROGRAMMERS WITHOUT SIGNIFICANT RETRAINING AMONG DIFFERENT MAPSES/APSES (NO STANDARD USER INTERFACE)

V. AVAILABILITY OF TRAINED PERSONNEL (TO DESIGN AND DEVELOP SPACE STATION SOFTWARE USING ADA)
- TRAINED IN SOFTWARE ENGINEERING USING ADA
  - DESIGN PRINCIPLES APPLICABLE TO ADA
  - (SPACE STATION STANDARD?) ADA SOFTWARE DESIGN METHODOLOGY
- TRAINED IN ADA LANGUAGE
- TRAINED IN USE OF ADA (STANDARDIZED?) TOOLS FOR SPACE STATION
- SUFFICIENT NUMBERS AND TRAINING TO MEET SPACE STATION SCHEDULES

NOTE: "NUMBERS" IN LEFT MARGIN IDENTIFY "TASKS TO BE CONTRACTED OUT" FOR DETAILED INVESTIGATION AND PROJECT RISK ASSESSMENT.

(CONSOLIDATED LIST FROM WHITE PAPER)

4 - RUN-TIME SUPPORT LIBRARIES SUCH AS MATH FUNCTIONS, GRAPHICS, ETC.
4 - MATURITY OF ADA TOOLS
4 - IN CODE OPTIMIZATION
4 - SPEED AND SIZE OF PRODUCED TARGET CODE TO MEET REAL-TIME
4 TARGET COMPUTER REQUIREMENTS
4 - IN PROGRAMMER PRODUCTIVITY
4 - TBD MAPSE+ TOOLS SUPPORTING BOTH HOST AND
4 TARGET SYSTEMS.
4 - EXECUTION SPEED OF ADA TOOLS
4 (ESPECIALLY COMPILER AND LINKER/BINDER)
4 - DESCRIPTIVE AND SPECIFIC ERROR MESSAGES BY ALL TOOLS
4 - USER-FRIENDLY INTERFACE TO ALL TOOLS
4 - IN RELIABILITY
4 - OF ADA TOOLS AND LIBRARIES
4 - OF PRODUCED TARGET CODE AND RUN-TIME SUPPORT SOFTWARE

NOTE: "NUMBERS" IN LEFT MARGIN IDENTIFY "TASKS TO BE CONTRACTED OUT"
FOR DETAILED INVESTIGATION AND PROJECT RISK ASSESSMENT.

ADA FOR SPACE STATION PROBLEMS AND CONCERNS - CONT	AVIONICS SYSTEMS DIVISION	
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VI. COSTS
(POSSIBLY PROHIBITIVE TO SPACE STATION PROJECT)

5 - COSTS OF ACQUIRING SUITABLE ADA TOOLS (SUPPORTING SPACE STATION
5 SCHEDULES) AND MAINTAINING TWO HOL SUPPORT SYSTEMS (HAL/S FOR SHUTTLE AND ADA
FOR SPACE STATION)

5 - COSTS OF REUSING AND MAINTAINING EXISTING HAL/S SOFTWARE IN ADA ENVIRONMENT
5 - RECODING FROM HAL/S TO ADA
5 - DEVELOPING, USE AND MAINTENANCE OF ADA TO HAL/S LANGUAGE INTERFACE STANDARD

5 - COSTS OF MAINTAINING SOFTWARE IF DUE TO ADA TARGET CODE PERFORMANCE
5 PROBLEMS, A SIGNIFICANT AMOUNT OF HAND-OPTIMIZATION IS REQUIRED IN
5 TIME-CRITICAL PARTS OF THE SOFTWARE.

- COSTS OF HIRING PERSONNEL WITH SUITABLE TRAINING IN ADA OR HIRING AND TRAINING SUCH PERSONNEL.
(SEE "5. AVAILABILITY OF TRAINED PERSONNEL")
- COSTS OF MODIFYING REQUIRED NASA MANAGEMENT PROCEDURES AND DOCUMENTATION TO ACCOMMODATE ADA
  - NASA SOFTWARE ACQUISITION MANAGEMENT PLAN FOR ADA
  - NASA PROGRAMMING STANDARDS FOR ADA
  - OTHERS TBD
- COSTS TO NASA FOR MODIFICATION OF CONTRACTOR'S MANAGEMENT PROCEDURES
AND DOCUMENTATION TO ACCOMMODATE ADA

NOTE: "NUMBERS" IN LEFT MARGIN IDENTIFY "TASKS TO BE CONTRACTED OUT"
FOR DETAILED INVESTIGATION AND PROJECT RISK ASSESSMENT.

BENCHMARK SPEED COMPARISONS OF VALIDATED ADA SYSTEMS USING JSC DEVELOPED TEST PROGRAMS

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	DEC VAX-ADA	DG/ROLM ADE	ARMY/SOFTECH ALS
COMPILE SPEED	1	3	17*
BINDER/LINKER SPEED	1	15	105*
EXECUTION SPEED	1	2	17*

"ADE" IS DATA GENERAL/ROLM ADA DEVELOPMENT ENVIRONMENT.
"ALS" IS ARMY/SOFTECH ADA LANGUAGE SYSTEM.
"*" DENOTES ONLY ABOUT 30% OF TESTS CASES COMPLETED ON ALS TO DATE.
27 TEST CASES RANGING IN SIZE FROM 44 TO 1189 LINES.
AVERAGE COMPILATION SPEED FOR VAX-ADA WAS 608 LINES/CPU MINUTE.
SPEED IS CPU TIME WITH SINGLE USER LOADING.
VAX 11/780 AND DG MV8000 COMPUTERS WERE USED AND ARE ASSUMED TO BE EQUIVALENT IN SPEED.

JSC ADA BENCHMARK TEST PROGRAMS	AVIONICS SYSTEMS DIVISION	
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NAME	# SOURCE LINES
SIMPLE IO TEST PROGRAM	44
FILE IO TEST PROGRAM	58
EXTENDED FILE IO TEST PROGRAM	203
FLOAT IO PACKAGE	428
FLOAT IO TEST PROGRAM	72
GENERIC FLOAT IO TEST PROGRAM	97
TERMINAL CONTROLLER PACKAGE	1261
TERMINAL CNTL TEST PROGRAM	266
STRING OPERATIONS PACKAGE	344
STRING TEST PROGRAM	98
MATRIX OPERATIONS PACKAGE	375
MATRIX TEST PROGRAM	208
TIMING FUNCTIONS PACKAGE	921
TIME FUNCTIONS TEST PROGRAM	125
DATASET BROWSE PROGRAM	493

NAME	# SOURCE LINES
DATASET RECORD SORT PROGRAM	261
DATASET RECORD SORT PROGRAM	261
MATH LIBRARY (SEQUENTIAL VERSION)	1189
SEQ MATH LIB TEST PROGRAM	364
SQRT ONLY TEST PROGRAM	282
EXP ONLY TEST PROGRAM	76
MATH LIBRARY (GENERIC VERSION)	1142
GENERIC MATH LIB TEST PROGRAM	360
DYNAMIC BUFFERING PACKAGE	186
DYNAMIC BUFFERING TEST PROGRAM	76
TASKING COMMUNICATION PACKAGE	302
TASK COMM TEST PROGRAM (COMMUNICATION)	117

REPRESNTATIVE ATOP'S

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APRIL 1985

ATOP NUMBER	COMPANY	ATOP TITLE	ATOP STATUS
03-05-02	BOEING AEROSPACE	INVESTIGATE THE EFFECTS OF TRANSLATING AN EXISTING EXPERT SYSTEM/ADA TRANSLATION SYSTEM TO THE ADA PROGRAMMING LANGUAGE	IN REVIEW
03-06-03	DRAPER LABS	ADA ARITHMETIC/ALGEBRARIC/TRIGONOMETRIC RUN TIME LIBRARY	APPROVED
03-02-01	FORD AEROSPACE	ADVANCED MICROPROCESSOR NETWORK STUDY	APPROVED
02-03-01	IBM/FSD	ADA BETA TEST SUPPORT ACTIVITIES (ADA, HAL/S BENCHMARK PROGRAMS)	APPROVED
02-03-02	ROCKWELL, INT.	STUDY OF ADA IN CONCURRENT REAL-TIME PROCESSING	APPROVED